IN THE CLAIMS:

1. (original) A system for controlling the physical behavior of an apparatus, the behavior of the apparatus estimated by an initial behavioral model, the system comprising:

a sensor element located in proximity to the apparatus for acquiring data that accurately characterizes the physical behavior of a machine component indicative of the physical behavior of the apparatus, the data measuring occurring during an abnormal period triggered by an event, the acquired data being indicative of the behavior of the machine component when in normal use;

a system processor which includes a tunable controller based on the initial behavioral model, the processor capable of generating a drive signal, estimating a behavioral model, tuning and adjusting the controller and generating a control signal,

wherein the processor adapts the initial model to an updated model based upon a respective transfer function of the respective acquired data, combines the updated model with a universal filter to create a relation that describes the behavior of the apparatus and creates a controller based on the relation such that the controller is tuned according to the updated model, and

wherein the control signal generated by the processor according to the controller is used to control the physical behavior of the apparatus.

2. (original) The system of claim 1, wherein the drive signal causes motion in the apparatus.

3. (original) The system of claim 1, wherein the relation is formulated as an optimal control problem.

4. (original) The system of claim 3, wherein the relation is solved by a method chosen from the group of methods consisting of: linear quadratic Gaussian (LQG), H-infinity and μ-synthesis.

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5. (original) The system of claim 1, wherein the universal filter includes a set of numbers provided by a user of the system.

6.(previously presented) The system of claim 1, wherein the universal filter is

$$\begin{bmatrix} z \\ r \\ y \end{bmatrix} = \underbrace{\begin{bmatrix} E_1 & E_2 & E_3 \\ F_1 & D_1 & 0 \\ F_2 & 0 & D_2 \end{bmatrix}}_{F} \begin{bmatrix} w \\ u \\ s \end{bmatrix}$$

where E_1, E_2, and E_3 are filters that specify the relationship between at least one performance variable, z, and at least one disturbance, w, at least one controller output, u, and at least one plant output, s, and F_1 and D_1 are filters that specify the relationship between at least one plant input, r, and at least one disturbance, w, and at least one controller output, u, and F_2 and D_2 are filters that specify the relationship between at least one controller input and at least one disturbance, w, and at least one plant output, s.

7. (original): The system of claim 1 wherein the controller is a digital signal processor (DSP).

8. (original): The system of claim 1 further comprising a second processor in data communication with the system processor.

9. (original): The system of claim 8, wherein the second processor is portable from the location of the system processor.

10. (cancelled): The system of claim 1, wherein the system begins acquiring data upon occurrence of a predefined event.

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11. (currently amended): The system of claim [1] [[10]], wherein the predefined event is an event selected from the group of events consisting of: input received from an operator, exceeding a threshold operating value in the apparatus, and the passage of a predetermined length of time.

12. (original): The system of claim 1, further comprising an actuator in electrical communication with the system processor, wherein the drive signal causes activation of the actuator and wherein the actuator is located such that the physical behavior of the apparatus is modified by the activation of the actuator.

13. (original): The system of claim 12, wherein transfer function data is collected between the actuator and the sensor element.

14. (original): The system of claim 13, wherein the sensor element gathers frequency data and wherein the accuracy of the updated model is adjustable as a function of the gathered frequency data.

15. (original): The system of claim 1, wherein the system processor further includes a signal conditioner.

16. (original): The system of claim 1, wherein the system processor further includes a signal amplifier.

17. (original): The system of claim 1, wherein the updated model is a model of minimal order.

18. (previously presented): A system for controlling the physical behavior of an apparatus, the behavior of the apparatus estimated by an initial behavioral model, the system comprising:

a sensor element located in proximity to the apparatus for acquiring data indicative of the physical behavior of a machine component of the apparatus;

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a system processor which includes a tunable controller based on the initial behavioral model, the processor capable of generating a drive signal, estimating a behavioral model, tuning and adjusting the controller and generating a control signal,

wherein the processor adapts the initial model to an updated model based upon a respective transfer function of the respective acquired data, combines the updated model with a universal filter to create a relation that describes the behavior of the apparatus and creates a controller based on the relation such that the controller is tuned according to the updated model,

wherein the control signal generated by the processor according to the controller is used to control the physical behavior of the apparatus; and

wherein the relation is a multivariate and fully coupled.

19. (previously presented): The system of claim 18, wherein the processor creates the updated model by non-linear curve-fitting thereby describing the updated model by a known mathematical equation according to the data gathered by the sensor.

20. (original): The system of claim 19, wherein an error function is associated with the known mathematical equation, the error function including log magnitude and phase information.

21. (previously presented): The system of claim 18, wherein the logarithmic error between the collected data and the initial behavioral model is:

$$\hat{\theta} = \arg \min_{\theta} \sum_{i=1}^{p} \sum_{j=1}^{q} \sum_{k=1}^{N} \left| \log\left(\frac{\hat{G}_{ij}(f_k, \theta)}{G_{jk}(f_k)} \right) \right|^2$$

where θ is a vector of parameters which describe the model, $\hat{G}_{ij}(f_k, \theta)$ is the frequency response of the model from actuator j to sensor i measured at frequency f_k, $G_{ik}(f_k)$ is the

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measured frequency response from actuator j to sensor i measured at frequency f_k, p is the number of sensors, q is the number of actuators, and N is the number of frequency points of interest.

22. (previously presented): A system for governing a controller usable to dictate motion of a machine component in normal use, comprising: a sensor which measures data that accurately characterizes the physical behavior of the component, the data measuring occurring during an abnormal period triggered by an event, a respective transfer function of the respective measured data being indicative of the behavior of the machine component when in normal use; and a signal processor which dynamically generates and uses a multivariable, fully-coupled mathematical relation of minimal order in conjunction with a universal filter to create a controller, the controller dictating motion after the abnormal period has ceased and when the equipment component is in normal use.

23. (original): The system of claim 22, wherein the mathematical relation provides an accurate model of the normal motion characteristics of the equipment component and the controller is created by using a method chosen from the group of methods consisting of: linear quadratic Gaussian (LQG), H-infinity and μ-synthesis.

24. (original): The system of claim 23, wherein the mathematical relation includes at least one parameter for governing the controller and wherein the parameter is a function of data measured by the sensor.

25. (previously presented): A method for governing motion in a physical system, the physical system being estimated by an initial behavioral model, comprising the steps of

inducing motion in the physical system;

measuring frequency data and utilizing the frequency data to create a respective transfer function of the respective frequency data which accurately characterizes a physical behavior of the system, comprising the motion in the system, indicative of the physical behavior of the system, the data measuring

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occurring during an abnormal period triggered by an event, the measured data

being indicative of the behavior of the machine component when in normal use;

updating the initial behavioral model to create an updated behavioral model which

accurately conforms to the measured data, using the updated behavioral model in

conjunction with a universal filter to create a command structure and applying

appropriate stimulus to the system to cause motion in the physical system, thereby

causing the physical system to behave in accordance with the command structure.

26. (previously presented): A method for creating an updated model for the motion

characteristics of a physical system from a previously stored model of the system, the

updated model governing the actions of a system controller which dictates motion in the

physical system, comprising the steps of: detecting the occurrence of a start event;

gathering data relating to the motion characteristics of the physical system during an

abnormal period of operation after the start event; updating the stored model by

comparing the a respective transfer function of the respective gathered data to the stored

model; and iteratively adapting the stored model until the stored model predicts the

motion characteristics of the system according to the gathered data; and storing the

updated model at an electronic memory location accessible to the system controller.

27. (previously presented): The method of claim 26, wherein the step of gathering data

comprises acquiring a frequency response to an induced motion to the physical system.

28. (previously presented): The method of claim 26, wherein the step of comparing the

gathered data comprises fitting a non-linear curve to the gathered data.

29. (previously presented): A method for controlling movement of a mechanical

apparatus based on the spatial location of a movable portion of the mechanical apparatus,

the movement of the portion initially estimated by a first mathematical model and

governed by a first controller which is based on the first mathematical model and a

universal filter, comprising the steps of:

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measuring frequency data and creating a respective transfer function of the respective frequency data, which accurately characterizes a physical behavior of the apparatus, comprising the motion in the system, indicative of the physical behavior of the apparatus, the data measuring occurring during an abnormal period triggered by an event, the measured data being indicative of the behavior of the machine component when in normal use;

introducing a first signal to induce motion in the movable portion;

measuring the motion and spatial location of the movable portion in response to the first signal;

updating the first mathematical model to generate a second mathematical model which approximates the motion of the movable portion and updating the first controller using the second mathematical model and the filter to create and solve an optimal control problem and thereby generate a second controller, such that the motion induced when a second signal is applied to the mechanical apparatus is well-predicted.

30. (previously presented): A method of creating a controller employed by a user to govern motion in a physical system comprising the steps of: generating an identification of the system by measuring the response of the system to commands and creating a respective transfer function for the respective measured response; accepting input from the user specifying certain parameters of the system; applying a universal filter to the input from the user to create a user-defined behavioral range for the physical system; creating a problem specification from the identification of the system and the behavioral range; and solving the problem specification, thereby creating the controller.

31. (previously presented): A system for creating a controller used by a user to govern motion in a physical system comprising: means for generating an identification of the system by measuring the response of the system to commands and creating a respective transfer function for the respective measured response; means for accepting input from the user specifying certain parameters of the system; means for applying a universal filter to the input from the user to create a user-defined behavioral range for the physical system; means for creating a problem specification from the identification of the system

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and the behavioral range; and means for solving the problem specification, thereby creating the controller.

32. (previously presented): A system for controlling the physical behavior of an apparatus, the behavior of the apparatus estimated by an initial behavioral model, the system comprising:

a sensor element located in proximity to the apparatus for acquiring data indicative of the physical behavior of a machine component of the apparatus, which accurately characterizes a physical behavior of the apparatus, comprising the motion in the apparatus, indicative of the physical behavior of the system, during a period when the apparatus is not in normal operation;

a system processor which includes a tunable controller based on the initial behavioral model, the processor capable of generating a drive signal, estimating a behavioral model, tuning and adjusting the controller and generating a control signal,

wherein the processor adapts the initial model to an updated model based upon a respective transfer function of the respective acquired data, combines the updated model with a universal filter to create a relation that describes the behavior of the apparatus and creates a controller based on the relation such that the controller is tuned according to the updated model, and

wherein the control signal generated by the processor according to the controller is used to control the physical behavior of the apparatus.

33. (previously presented): A system for governing a controller usable to dictate motion of a machine component in normal use, comprising: a sensor which measures data that accurately characterizes the physical behavior of the component, the data measuring occurring during an abnormal period triggered by an event during which the physical behavior of the component is stimulated by preselected control signals, a respective transfer function of the respective measured data being indicative of the behavior of the machine component when in normal use, under the influence of the preselected control signals; and a signal processor which dynamically generates and uses a multivariable,

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fully-coupled mathematical relation of minimal order in conjunction with a universal filter to create a controller utilizing the respective transfer functions, the controller dictating motion after the abnormal period has ceased and when the equipment component is in normal use.

34. (previously presented): A method for governing motion in a physical system, the physical system being estimated by an initial behavioral model, comprising the steps of:

inducing motion in the physical system during a period when the physical system is not in normal operation;

measuring frequency data and creating a respective transfer function of the respective frequency data, which accurately characterizes a physical behavior of the apparatus, comprising the motion in the system; indicative of the physical behavior of the apparatus, the data measuring occurring during an abnormal period triggered by an event, the transfer function of the respective measured data being indicative of the behavior of the machine component when in normal use;

updating the initial behavioral model utilizing the respective transfer function to create an updated behavioral model which accurately conforms to the measured data;

using the updated behavioral model in conjunction with a universal filter to create a command structure; and

applying appropriate stimulus to the system to cause motion in the physical system, thereby causing the physical system to behave in accordance with the command structure.

35. (previously presented): A method for creating an updated model for the motion characteristics of a physical system from a previously stored model of the system, the updated model governing the actions of a system controller which dictates motion in the physical system, comprising the steps of: detecting the occurrence of a start event; gathering data relating to the motion characteristics of the physical system during an abnormal period based upon preselected induced control signals, and creating a respective transfer function of the respective gathered data; updating the stored model by

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comparing the respective transfer function of the respective gathered data to the stored model; and iteratively adapting the stored model until the stored model predicts the motion characteristics of the system according to the gathered data; and utilizing a universal filter and the adapted stored model creating a relation that describes the behavior of the physical system.

36. (previously presented): A method for controlling movement of a mechanical apparatus based on the spatial location of a movable portion of the mechanical apparatus, the movement of the portion initially estimated by a first mathematical model and governed by a first controller which is based on the first mathematical model and a mathematical filter, comprising the steps of:

    introducing a first signal to induce motion in the movable portion during a period of time when the mechanical apparatus is not in normal operation;

    measuring data and creating a respective transfer function of the respective measured data, which accurately characterizes a physical behavior of the apparatus, comprising the motion and spatial location of the movable portion in response to the first signal which accurately characterizes a physical behavior of the apparatus, comprising the motion in the system indicative of the physical behavior of the apparatus, the data measuring occurring during an abnormal period triggered by an event, the measured data being indicative of the behavior of the machine component when in normal use;

    updating the first mathematical model to generate a second mathematical model which approximates the motion of the movable portion utilizing the respective transfer functions and updating the first controller using the second mathematical model and the filter to create and solve an optimal control problem and thereby generate a second controller, such that the motion induced when a second signal is applied to the mechanical apparatus is well-predicted.

37. (previously presented): A method of creating a controller employed by a user to govern motion in a physical system comprising the steps of: generating an identification of the system by measuring the response of the system to commands during a period of

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time when the physical system is not in operation based upon preselected commands by creating a respective transfer function for the respective measured response; accepting input from the user specifying certain parameters of the system; applying a universal filter to the input from the user to create a user-defined behavioral range for the physical system; creating a problem specification from the identification of the system and the behavioral range; and solving the problem specification, thereby creating the controller.

38. (previously presented): A system for creating a controller used by a user to govern motion in a physical system comprising: means for generating an identification of the system by measuring the response of the system to commands during a period of time when the physical system is not in normal operation based upon a plurality of preselected commands by creating a respective transfer function for the respective measured response; means for accepting input from the user specifying certain parameters of the system; means for applying a universal filter to the input from the user to create a user-defined behavioral range for the physical system; means for creating a problem specification from the identification of the system and the behavioral range; and means for solving the problem specification, thereby creating the controller.

39. (previously presented): A system for creating a controller used by a user to govern motion in a physical system comprising:

controller means for injecting motion control signals to govern motion in the physical system having feedback to the controller means;

means for disabling the controller means and substituting a temporary control signal generator injecting preselected control signals into the physical system to enable measurement of response to the preselected control signals;

means for generating an update of a preexisting model of the physical system based upon respective transfer functions of the respective measured responses;

means for using the updated model along with a universal filter for generating a new controller means by computing new controller variables; and,

means for connecting the new controller means to the physical system.

40. (original): The apparatus of claim 39 further comprising:

  the means for generating a new controller includes means for downloading the computed new controller variables to the existing controller means.

41. (original): The apparatus of claim 40 further comprising:

  the new controller variables are controller gains.

42. (previously presented): A method for creating a controller used by a user to govern motion in a physical system comprising:

  injecting motion control signals to govern motion in the physical system having feedback to a controller injecting the motion control signals;

  disabling the controller and substituting a temporary control signal generator injecting preselected control signals into the physical system to enable measurement of response to the preselected control signals;

  measuring data and creating respective transfer functions for the respective measured data, which accurately characterizes a physical behavior of the physical system, comprising the motion of the physical system in response to the motion control signal which accurately characterizes a physical behavior of the physical system, comprising the motion in the physical system indicative of the physical behavior of the physical system, the data measuring occurring during an abnormal period triggered by an event, the measured data being indicative of the behavior of the physical system when in normal use;

  generating an update of a preexisting model of the physical system based upon the respective transfer functions for the respective measured responses;

  using the updated model along with a universal filter for generating a new controller by computing new controller variables; and,

  connecting the new controller to the physical system.

43. (original): The method of claim 42 further comprising:

  the step of generating a new controller includes downloading the computed new controller variables to the existing controller.

44. (original): The apparatus of claim 43 further comprising:

the new controller variables are controller gains.

45. (previously presented): A system for controlling the physical behavior of an apparatus, the behavior of the apparatus estimated by an initial behavioral model, the system comprising:

a sensor element located in proximity to the apparatus for acquiring data indicative of the physical behavior of a machine component of the apparatus;

a system processor which includes a tunable controller based on the initial behavioral model, the processor capable of generating a drive signal, estimating a behavioral model, tuning and adjusting the controller and generating a control signal,

wherein the processor adapts the initial model to an updated model based upon the acquired data, combines the updated model with a universal filter to create a relation that describes the behavior of the apparatus and creates a controller based on the relation such that the controller is tuned according to the updated model,

and wherein the control signal generated by the processor according to the controller is used to control the physical behavior of the apparatus; and

wherein the universal filter is

$$
\begin{bmatrix} z \\ r \\ y \end{bmatrix} = \underbrace{\begin{bmatrix} E_1 & E_2 & E_3 \\ F_1 & D_1 & 0 \\ F_2 & 0 & D_2 \end{bmatrix}}_{F} \begin{bmatrix} w \\ u \\ s \end{bmatrix}
$$

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where E_1, E_2, and E_3 are filters that specify the relationship between at least one performance variable, z, and at least one disturbance, w, at least one controller output, u, and at least one plant output, s, and F_1 and D_1 are filters that specify the relationship between at least one plant input, r, and at least one disturbance, w, and at least one controller output, u, and F_2 and D_2 are filters that specify the relationship between at least one controller input and at least one disturbance, w, and at least one plant output, s.

46. (previously presented):   A system for controlling the physical behavior of an apparatus, the behavior of the apparatus estimated by an initial behavioral model, the system comprising:

a sensor element located in proximity to the apparatus for acquiring data indicative of the physical behavior of the apparatus;

a system processor which includes a tunable controller based on the initial behavioral model, the processor capable of generating a drive signal, estimating a behavioral model, tuning and adjusting the controller and generating a control signal,

wherein the processor adapts the initial model to an updated model based upon a respective transfer function for the respective acquired data, by dynamically generating a multivariable, fully-coupled mathematical relation of minimal order, and combines the updated model with a universal filter to create a relation that describes the behavior of the apparatus and creates a controller based on the relation such that the controller is tuned according to the updated model, and

wherein the control signal generated by the processor according to the controller is used to control the physical behavior of the apparatus.

47. (previously presented): A method for governing motion in a physical system, the physical system being estimated by an initial behavioral model, comprising the steps of:

inducing motion in the physical system, measuring frequency data which characterizes the motion in the system;

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updating the initial behavioral model utilizing a respective transfer

function for the respective measured frequency data to create an updated

behavioral model which accurately conforms to the measured data;

using the updated behavioral model in conjunction with a universal filter

to create a command structure by dynamically generating a multivariable, fully

coupled mathematical relation of minimal order; and

applying appropriate stimulus to the system to cause motion in the

physical system, thereby causing the physical system to behave in accordance

with the command structure.

48. (previously presented): A method for controlling movement of a mechanical

apparatus based on the spatial location of a movable portion of the mechanical apparatus,

the movement of the portion initially estimated by a first mathematical model and

governed by a first controller which is based on the first mathematical model and a

mathematical filter, comprising the steps of:

introducing a first signal to induce motion in the movable portion;

measuring the motion and spatial location of the movable portion in response to

the first signal;

updating the first mathematical model utilizing a respective transfer

function of the respective measured response, to generate a second mathematical

model which approximates the motion of the movable portion and updating the

first controller using the second mathematical model and the filter by dynamically

generating a multivariable, fully coupled mathematical relation of minimal order,

to create and solve an optimal control problem and thereby generate a second

controller, such that the motion induced when a second signal is applied to the

mechanical apparatus is well-predicted.

49. (previously presented): A system for controlling the physical behavior of an

apparatus, the behavior of the apparatus estimated by an initial behavioral model, the

system comprising:

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a sensor element located in proximity to the apparatus for acquiring data indicative of the physical behavior of a machine component of the apparatus during a period when the apparatus is not in normal operation;

a system processor which includes a tunable controller based on the initial behavioral model, the processor capable of generating a drive signal, estimating a behavioral model, tuning and adjusting the controller and generating a control signal,

wherein the processor adapts the initial model to an updated model based upon a respective transfer function for the respective acquired data, by dynamically generating a multivariable, fully-coupled mathematical relation of minimal order, and combines the updated model with a universal filter to create a relation that describes the behavior of the apparatus and creates a controller based on the relation such that the controller is tuned according to the updated model, and

wherein the control signal generated by the processor according to the controller is used to control the physical behavior of the apparatus.

50. (previously presented): A method for governing motion in a physical system, the physical system being estimated by an initial behavioral model, comprising the steps of:

inducing motion in the physical system during a period when the physical system is not in normal operation, measuring frequency data which characterizes the motion in the system;

updating the initial behavioral model based upon a respective transfer function for the respective acquired data to create an updated behavioral model which accurately conforms to the measured data by dynamically generating a multivariable, fully-coupled mathematical relation of minimal order, and combining the updated behavioral model with a universal filter;

using the updated behavioral model in conjunction with a universal filter to create a command structure; and

applying appropriate stimulus to the system to cause motion in the
physical system, thereby causing the physical system to behave in accordance
with the command structure.

51. (previously presented): A method for controlling movement of a mechanical
apparatus based on the spatial location of a movable portion of the mechanical apparatus,
the movement of the portion initially estimated by a first mathematical model and
governed by a first controller which is based on the first mathematical model and a
mathematical filter, comprising the steps of:

introducing a first signal to induce motion in the movable portion during a
period of time when the mechanical apparatus is not in normal operation;

measuring the motion and spatial location of the movable portion in
response to the first signal;

updating the first mathematical model based upon a respective transfer
function for the respective measures response to generate a second mathematical
model which approximates the motion of the movable portion by dynamically
generating a multivariable, fully-coupled mathematical relation of minimal order,
and updating the first controller using the relation and the filter to create and solve
an optimal control problem and thereby generate a second controller, such that the
motion induced when a second signal is applied to the mechanical apparatus is
well-predicted.

52. (previously presented): A method for creating a controller used by a user to govern
motion in a physical system comprising:

injecting motion control signals to govern motion in the physical system having
feedback to a controller injecting the motion control signals;

disabling the controller and substituting a temporary control signal generator
injecting preselected control signals into the physical system to enable measurement of
response to the preselected control signals;

generating an update of a preexisting model of the physical system based upon a
respective transfer function for the respective measured responses by dynamically
generating a multivariable, fully-coupled mathematical relation of minimal order;

using the updated model along with a universal filter for generating a new
controller by computing new controller variables; and,

connecting the new controller to the physical system.

53. (original): A method for governing motion in a physical system, the physical system
being estimated by an initial behavioral model, comprising the steps of:

inducing motion in the physical system, measuring frequency data which
characterizes the motion in the system;

updating the initial behavioral model to create an updated behavioral
model which accurately conforms to the measured data;

using the updated behavioral model in conjunction with a universal filter
to create a command structure and applying appropriate stimulus to the system to
cause motion in the physical system, thereby causing the physical system to
behave in accordance with the command structure;

wherein the universal filter is

$$
\begin{bmatrix} z \\ r \\ y \end{bmatrix} = \underbrace{\begin{bmatrix} E_1 & E_2 & E_3 \\ F_1 & D_1 & 0 \\ F_2 & 0 & D_2 \end{bmatrix}}_{F} \begin{bmatrix} w \\ u \\ s \end{bmatrix}
$$

where E_1, E_2, and E_3 are filters that specify the relationship
between at least one performance variable, z, and at least one disturbance,
w, at least one controller output, u, and at least one plant output, s, and F_1
and D_1 are filters that specify the relationship between at least one plant
input, r, and at least one disturbance, w, and at least one controller output,
u, and F_2 and D_2 are filters that specify the relationship between at least

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one controller input and at least one disturbance, w, and at least one plant output, s.

54. (previously presented): A method for controlling movement of a mechanical apparatus based on the spatial location of a movable portion of the mechanical apparatus, the movement of the portion initially estimated by a first mathematical model and governed by a first controller which is based on the first mathematical model and a universal filter, comprising the steps of:

introducing a first signal to induce motion in the movable portion;

measuring the motion and spatial location of the movable portion in response to the first signal;

updating the first mathematical model to generate a second mathematical model which approximates the motion of the movable portion and updating the first controller using the second mathematical model and the universal filter to create and solve an optimal control problem and thereby generate a second controller, such that the motion induced when a second signal is applied to the mechanical apparatus is well-predicted;

wherein the universal filter is

$$\begin{bmatrix} z \\ r \\ y \end{bmatrix} = \underbrace{\begin{bmatrix} E_1 & E_2 & E_3 \\ F_1 & D_1 & 0 \\ F_2 & 0 & D_2 \end{bmatrix}}_{F} \begin{bmatrix} w \\ u \\ s \end{bmatrix}$$

where E_1, E_2, and E_3 are filters that specify the relationship between at least one performance variable, z, and at least one disturbance, w, at least one controller output, u, and at least one plant output, s, and F_1 and D_1 are filters that specify the relationship between at least one plant input, r, and at least one disturbance, w, and at least one controller output, u, and F_2 and D_2 are filters that specify the relationship between at least

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one controller input and at least one disturbance, w, and at least one plant output, s.

55. (original): A system for controlling the physical behavior of an apparatus, the behavior of the apparatus estimated by an initial behavioral model, the system comprising:

a sensor element located in proximity to the apparatus for acquiring data indicative of the physical behavior of the apparatus during a period when the apparatus is not in normal operation;

a system processor which includes a tunable controller based on the initial behavioral model, the processor capable of generating a drive signal, estimating a behavioral model, tuning and adjusting the controller and generating a control signal;

wherein the processor adapts the initial model to an updated model based upon the acquired data, combines the updated model with a universal filter to create a relation that describes the behavior of the apparatus and creates a controller based on the relation such that the controller is tuned according to the updated model; and

wherein the control signal generated by the processor according to the controller is used to control the physical behavior of the apparatus;

wherein the universal filter is

$$
\begin{bmatrix} z \\ r \\ y \end{bmatrix} = \underbrace{\begin{bmatrix} E_1 & E_2 & E_3 \\ F_1 & D_1 & 0 \\ F_2 & 0 & D_2 \end{bmatrix}}_{F} \begin{bmatrix} w \\ u \\ s \end{bmatrix}
$$

where E_1, E_2, and E_3 are filters that specify the relationship between at least one performance variable, z, and at least one disturbance, w, at least one controller output, u, and at least one plant output, s, and F_1 and D_1 are filters that specify the relationship between at least one plant

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input, r, and at least one disturbance, w, and at least one controller output, u, and F_2 and D_2 are filters that specify the relationship between at least one controller input and at least one disturbance, w, and at least one plant output, s.

56. (original): A method for governing motion in a physical system, the physical system being estimated by an initial behavioral model, comprising the steps of:

inducing motion in the physical system during a period when the physical system is not in normal operation, measuring frequency data which characterizes the motion in the system;

updating the initial behavioral model to create an updated behavioral model which accurately conforms to the measured data;

using the updated behavioral model in conjunction with a universal filter to create a command structure and applying appropriate stimulus to the system to cause motion in the physical system, thereby causing the physical system to behave in accordance with the command structure;

wherein the universal filter is

$$\begin{bmatrix} z \\ r \\ y \end{bmatrix} = \underbrace{\begin{bmatrix} E_1 & E_2 & E_3 \\ F_1 & D_1 & 0 \\ F_2 & 0 & D_2 \end{bmatrix}}_{F} \begin{bmatrix} w \\ u \\ s \end{bmatrix}$$

where E_1, E_2, and E_3 are filters that specify the relationship between at least one performance variable, z, and at least one disturbance, w, at least one controller output, u, and at least one plant output, s, and F_1 and D_1 are filters that specify the relationship between at least one plant input, r, and at least one disturbance, w, and at least one controller output, u, and F_2 and D_2 are filters that specify the relationship between at least one controller input and at least one disturbance, w, and at least one plant output, s.

57. (original): A method for controlling movement of a mechanical apparatus based on the spatial location of a movable portion of the mechanical apparatus, the movement of the portion initially estimated by a first mathematical model and governed by a first controller which is based on the first mathematical model and a mathematical filter, comprising the steps of:

introducing a first signal to induce motion in the movable portion during a period of time when the mechanical apparatus is not in normal operation;

measuring the motion and spatial location of the movable portion in response to the first signal; updating the first mathematical model to generate a second mathematical model which approximates the motion of the movable portion and updating the first controller using the second mathematical model and the filter to create and solve an optimal control problem and thereby generate a second controller, such that the motion induced when a second signal is applied to the mechanical apparatus is well-predicted;

wherein the universal filter is

$$
\begin{bmatrix} z \\ r \\ y \end{bmatrix} = \underbrace{\begin{bmatrix} E_1 & E_2 & E_3 \\ F_1 & D_1 & 0 \\ F_2 & 0 & D_2 \end{bmatrix}}_{F} \begin{bmatrix} w \\ u \\ s \end{bmatrix}
$$

where E_1, E_2, and E_3 are filters that specify the relationship between at least one performance variable, z, and at least one disturbance, w, at least one controller output, u, and at least one plant output, s, and F_1 and D_1 are filters that specify the relationship between at least one plant input, r, and at least one disturbance, w, and at least one controller output, u, and F_2 and D_2 are filters that specify the relationship between at least one controller input and at least one disturbance, w, and at least one plant output, s.

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58. (original): A method for creating a controller of the type used by a user to govern motion in a physical system comprising:

injecting motion control signals to govern motion in the physical system having feedback to a controller injecting the motion control signals;

disabling the controller and substituting a temporary control signal generator injecting preselected control signals into the physical system to enable measurement of response to the preselected control signals;

generating an update of a preexisting model of the physical system based upon the measured responses;

using the updated model along with a universal filter for generating a new controller by computing new controller variables; and,

connecting the new controller to the physical system;

wherein the universal filter is

$$
\begin{bmatrix} z \\ r \\ y \end{bmatrix} = \underbrace{\begin{bmatrix} E_1 & E_2 & E_3 \\ F_1 & D_1 & 0 \\ F_2 & 0 & D_2 \end{bmatrix}}_{F} \begin{bmatrix} w \\ u \\ s \end{bmatrix}
$$

where E_1, E_2, and E_3 are filters that specify the relationship between at least one performance variable, z, and at least one disturbance, w, at least one controller output, u, and at least one plant output, s, and F_1 and D_1 are filters that specify the relationship between at least one plant input, r, and at least one disturbance, w, and at least one controller output, u, and F_2 and D_2 are filters that specify the relationship between at least one controller input and at least one disturbance, w, and at least one plant output, s.

59. (original): The system of claim 45, wherein the relation is solved by a method chosen from the group of methods consisting of: linear quadratic Gaussian (LQG), H-infinity and μ-synthesis.

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60. (original): The system of claim 45, further comprising an actuator in electrical communication with the system processor, wherein the drive signal causes activation of the actuator and wherein the actuator is located such that the physical behavior of the apparatus is modified by the activation of the actuator.

61. (original): The system of claim 60, wherein transfer function data is collected between the actuator and the sensor element.

62. (original): The system of claim 1, wherein the processor creates the updated model by non-linear curve-fitting thereby describing the updated model by a known mathematical equation according to the data gathered by the sensor.

63. (original): The system of claim 62, wherein an error function is associated with the known mathematical equation, the error function including log magnitude and phase information.

64. (original): The system of claim 63, wherein the logarithmic error between the collected data and the initial behavioral model is:

$$\hat{\theta} = \arg \min_{\theta} \sum_{l=1}^{p} \sum_{j=1}^{q} \sum_{k=1}^{N} \left| \log \left(\frac{\hat{G}_{ij}(f_k, \theta)}{G_{jk}(f_k)} \right) \right|^2$$

where θ is a vector of parameters which describe the model, $\hat{G}_{ij}(f_k, \theta)$ is the frequency response of the model from actuator j to sensor i measured at frequency f_k, $G_{ik}(f_k)$ is the measured frequency response from actuator j to sensor i measured at frequency f_k, p is the number of sensors, q is the number of actuators, and N is the number of frequency points of interest.

65. (previously presented): A system for controlling the physical behavior of an apparatus, the behavior of the apparatus estimated by an initial behavioral model, the system comprising:

a sensor element located in proximity to the apparatus for acquiring data that accurately characterizes the physical behavior of a machine component indicative of the physical behavior of the apparatus, the data measuring occurring during an abnormal period triggered by an event, the acquired data being indicative of the behavior of the machine component when in normal use;

a system processor which includes a tunable controller based on the initial behavioral model, the processor capable of generating a drive signal, estimating a behavioral model, tuning and adjusting the controller and generating a control signal,

wherein the processor adapts the initial model to an updated model based upon the acquired data, combines the updated model with a universal filter to create a relation that describes the behavior of the apparatus and creates a controller based on the relation such that the controller is tuned according to the updated model, and

wherein the control signal generated by the processor according to the controller is used to control the physical behavior of the apparatus;

wherein the universal filter is

$$\begin{bmatrix} z \\ r \\ y \end{bmatrix} = \underbrace{\begin{bmatrix} E_1 & E_2 & E_3 \\ F_1 & D_1 & 0 \\ F_2 & 0 & D_2 \end{bmatrix}}_{F} \begin{bmatrix} w \\ u \\ s \end{bmatrix}$$

where E_1, E_2, and E_3 are filters that specify the relationship between at least one performance variable, z, and at least one disturbance, w, at least one controller output, u, and at least one plant output, s, and F_1 and D_1 are filters that specify the relationship between at least one plant input, r, and at least one disturbance, w, and at least one controller output, u, and F_2 and D_2 are filters that specify the relationship between at least one controller input and at least one disturbance, w, and at least one plant output, s.

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66. (previously presented): A system for controlling the physical behavior of an apparatus, the behavior of the apparatus estimated by an initial behavioral model, the system comprising:

a sensor element located in proximity to the apparatus for acquiring data indicative of the physical behavior of a machine component of the apparatus;

a system processor which includes a tunable controller based on the initial behavioral model, the processor capable of generating a drive signal, estimating a behavioral model, tuning and adjusting the controller and generating a control signal,

wherein the processor adapts the initial model to an updated model based upon the acquired data, combines the updated model with a universal filter to create a relation that describes the behavior of the apparatus and creates a controller based on the relation such that the controller is tuned according to the updated model,

wherein the control signal generated by the processor according to the controller is used to control the physical behavior of the apparatus; and

wherein the relation is a multivariate and fully coupled;

wherein the logarithmic error between the collected data and the initial behavioral model is:

$$\hat{\theta} = \arg\ \min_{\theta} \sum_{i=1}^{p}\ \sum_{j=1}^{q}\ \sum_{k=1}^{N}\left|\log\left(\frac{\hat{G}_{ij}(f_k,\theta)}{G_{jk}(f_k)}\right)\right|^2$$

where θ is a vector of parameters which describe the model, $\hat{G}_{ij}(f_k,\theta)$ is the frequency response of the model from actuator j to sensor i measured at frequency f_k, $G_{ik}(f_k)$ is the measured frequency response from actuator j to sensor i measured at frequency f_k, p is the number of sensors, q is the number of actuators, and N is the number of frequency points of interest.

67. (previously presented): A system for controlling the physical behavior of an apparatus, the behavior of the apparatus estimated by an initial behavioral model, the system comprising:

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a sensor element located in proximity to the apparatus for acquiring data that accurately characterizes the physical behavior of a machine component indicative of the physical behavior of the apparatus, the data measuring occurring during an abnormal period triggered by an event, the acquired data being indicative of the behavior of the machine component when in normal use;

a system processor which includes a tunable controller based on the initial behavioral model, the processor capable of generating a drive signal, estimating a behavioral model, tuning and adjusting the controller and generating a control signal,

wherein the processor adapts the initial model to an updated model based upon the acquired data, combines the updated model with a universal filter to create a relation that describes the behavior of the apparatus and creates a controller based on the relation such that the controller is tuned according to the updated model, and

wherein the control signal generated by the processor according to the controller is used to control the physical behavior of the apparatus;

wherein the processor creates the updated model by non-linear curve-fitting thereby describing the updated model by a known mathematical equation according to the data gathered by the sensor;

wherein an error function is associated with the known mathematical equation, the error function including log magnitude and phase information; and,

wherein the logarithmic error between the collected data and the initial behavioral model is:

$$\hat{\theta} = \arg\min_{\theta} \sum_{i=1}^{p} \sum_{j=1}^{q} \sum_{k=1}^{N} \left| \log\left(\frac{\hat{G}_{ij}(f_k,\theta)}{G_{jk}(f_k)} \right) \right|^2$$

where θ is a vector of parameters which describe the model, $\hat{G}_{ij}(f_k,\theta)$ is the frequency response of the model from actuator j to sensor i measured at frequency f_k, $G_{ik}(f_k)$ is the measured frequency response from actuator j to sensor i

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measured at frequency f_k, p is the number of sensors, q is the number of actuators, and N

is the number of frequency points of interest.